AUDIO HUM CHECK LIST

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THE elimination or reduction of a.c. hum is one of the most common problems in servicing audio amplifiers and the audio portion of receivers. There are a great many causes of hum, and the technician's ability to remember them seems to vary inversely with his need. The purpose of this article is to condense some of the published material on this subject into a check-list of hum causes and remedies —a list which the harried technician can refer to in a hurry when things look grim on the bench. No claim is made that the list is exhaustive. Very little theory is given, the reader being referred to the literature indicated in the footnotes for detailed discussion. At the end of the article there are a few somewhat heroic hum-elimination measures for use when the situation is drastic enough to warrant them.

Power supply hum

1. Line cord plug reversed in a.c. wall outlet.
2. Defective rectifier tube.
3. Defective electrolytic filter capacitor. Replace the electrolytic, or shunt a paper capacitor across it.
4. Defective filter choke.
5. Choke needs tuning. Shunt it with capacitor so the combination tunes to the hum frequency.[1]
6. Power transformer and choke improperly oriented or too close to audio transformers. Should be at opposite end of chassis from input transformer. (Rotate a.f. transformers for minimum hum.)
7. Omitted or open a.c. line filter capacitors.
8. Lead from power transformer center-tap goes through one hole in chassis while other leads from same winding go through another hole. This forms a single magnetic turn which induces hum-producing circulating a.c. around a portion of the chassis.
9. 110-volt a.c. input wiring too close to hum-sensitive elements.
10. Mechanical vibration from transformer or vibrator causes cyclic variation in spacing of tube elements. This hum is produced by microphonism in tube.
11. Poor waveform in a.c. supply line.
12. A.c. supply voltage too high or too low.
13. Isolation transformer (1:1 voltage ratio) needed in a.c. supply line.
14. Separate power-supply chassis too close to amplifier chassis.
15. Hum - balancing potentiometer across filament supply has been omitted; is improperly adjusted; or is the wrong size.[1, 2]
16. Half of power-transformer secondary defective in full-wave power supply.
17. Unequal emission from plates of full-wave rectifier tube.
18. Power-transformer filament winding not grounded at center-tap or end of winding.
19. Power-supply filter overloaded. Add regulator or reduce load.[3]
20. Shield on mercury-vapor rectifier omitted or ungrounded.
21. Chassis forms a common core-lamination between power and audio transformers. Mount power transformer on brass bushings.
22. Common lead used to carry filament return and B minus between separate power supply and amplifier chassis. Use separate leads for each.
23. Filament leads not twisted.
24. Remount power transformer vertically so laminations are at a right angle to chassis.[4]
25. Filament and 110-volt a.c. leads physically located too far above or below chassis.

Hum in associated circuits

1. No earth ground on amplifier.
2. No common grounding conductor between associated chassis.
3. Feedback due to multiple earth grounds on interconnected equipment.
4. Defective connection between amplifier and microphone or turntable.
5. Impedance mismatch between amplifier and microphone and turntable.
6. Unbalanced microphone or turntable is feeding balanced input to amplifier. Install 1:1 isolation transformer between them.
7. Coiled-up slack in microphone or turntable cables which become effective hum-pickup coils.
8. A.c. power line cabled with microphone pair or other audio circuits.
9. Inductive coupling between turntable motor and magnetic pickup. Try two-conductor shielded pair between amplifier and pickup, the braid being used only as a shield and grounded to the amplifier chassis. Bond motor casing to amplifier ground with separate wire. (A 4-pole motor is less troublesome in this respect than a 2-pole unit.)
10. Capacitive coupling between a.c. line and both the turntable motor frame and the amplifier chassis. Ground motor frame to amplifier chassis by separate conductor, rather than by the pickup shield. The latter should be grounded only to the amplifier chassis and should carry only signal current.[5]
11. Low-frequency rumble from turntable mistaken for a.c. hum. Check for mechanical misalignment of motor and driving system, and dried-out or missing rubber mountings on the motor.
12. Hum picked up by tuner antenna from nearby power lines. Reorient or relocate antenna.
13. Modulation hum (or tunable hum) from tuner. Generally due to defective or missing line filter capacitor, or to leakage between heater and cathode in r.f., oscillator and converter tubes. In superhets, may also be caused by insufficiently filtered oscillator plate supply.[1]
14. Speaker hum-bucking coil leads reversed.
15. Defective electrodynamic speaker field winding used as choke.
16. Poorly soldered joints at junctions of chokes and filter capacitors with chassis.
17. Acoustic coupling between loudspeaker and input tube. Put a

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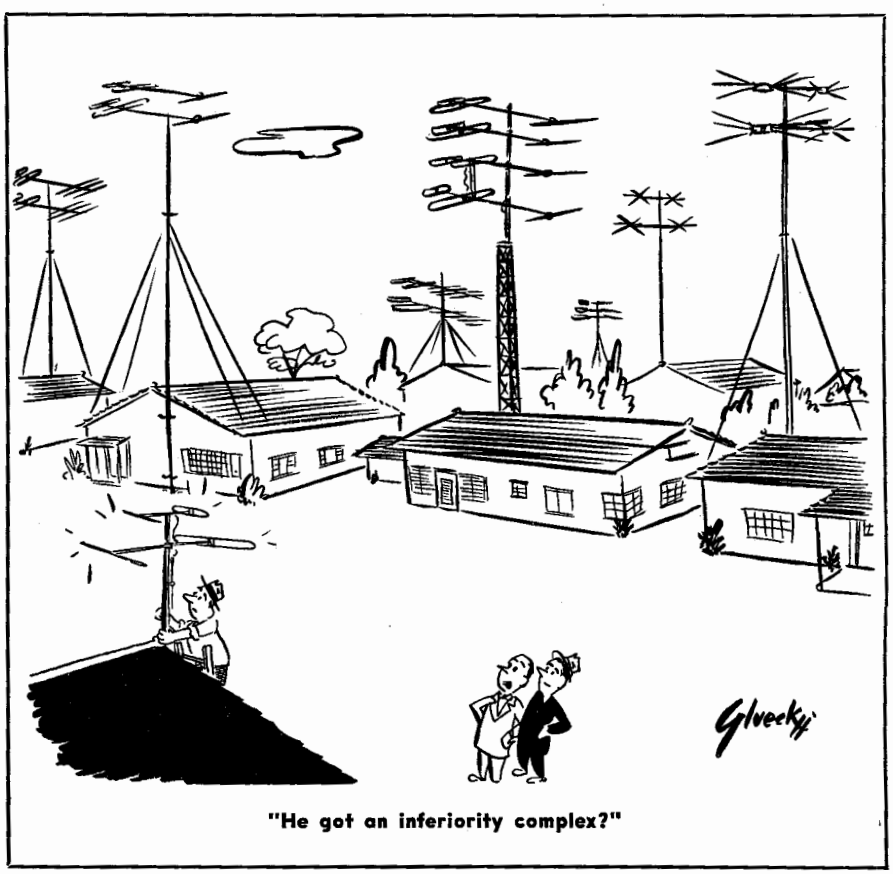
heavy rubber band around the tube to dampen the resulting vibration — or install floating socket.

18. Interference from short-wave diathermy machines, fluorescent lamps, commutator sparking, and other non-audio sources. Try commercial interference filter, or an isolation transformer with electrostatic shield in the a.c. line, the low-level input circuit, or in both.
19. Dynamic microphone located in an a.c. field.
20. Magnetic field in vicinity of tape-recorder playback head. Locate a small piece of sheet iron or Permalloy near the playback head and determine experimentally its exact position for minimum or zero hum.[2]

Hum in amplifier proper

1. Gain controls of unused channels advanced with no microphone or turntable connected.
2. Defective tubes.
3. Defective decoupling resistors and capacitors.
4. Open or leaky cathode-bypass, screen bypass, and coupling capacitors.
5. High-resistance non-soldered grounds. For example: Between transformer casings and chassis and riveted ground lugs.
6. Grid-lead shield not grounded.
7. Dirty or corroded grid caps or tube-base prongs.
8. Grid-cap shield missing or ungrounded.
9. Grid leads too close to filament leads.
10. Grid leads too long. This may cause inductive or capacitive hum pickup, especially if they sag and alter the lead dress.
11. Grid lead and grid return too far apart. The loop they form across cathode and grid must be reduced in area by running these leads close together or by having the grid-lead shield serve as the grid return.[5]
12. Circuit grounds made to wrong point or points on chassis.[2, 5]
13. Metallic tube shields missing or not grounded to chassis.
14. Open grid circuit.
15. Unmatched push-pull tubes.
16. Unshielded plate lead in low-level stages.
17. Magnetized tubes. Replace, or demagnetize them with a recording-tape degausser, watchmaker's demagnitizer, or other effective means.[2]
18. Design calls for a tube of inherently high hum-level. For example a 6SJ7 which has the grid lead brought out to a prong in the tube base close to filament prongs tends to have a higher level than a 6J7 which has the grid lead brought out to a grid cap.[2, 4]
19. Heater-to-cathode leakage inside the tube. Replace tube or increase capacitance of cathode bypass capacitor or reduce the heater voltage.
20. Leakage or capacitive coupling between tube prongs across tube socket insulation.
21. Improper bias due to defective cathode resistor or bias cell.
22. Audio transformer leads reversed.
23. Shell of metal tubes not grounded.
24. Screen bypass too small on pentodes (increase to improve filtering). Plate-load resistor too large on triodes (decrease resistance to reduce low-frequency response).
25. Omitted or defective R-C filter network in plate circuit of critical stages.[3]
26. Defective hum-bucking coils in input transformers.
27. Leakage between bypass capacitors in single-cam multiple capacitor assemblies.
28. Replace single common cathode resistor in push-pull stages by adjustable independently bypassed resistors for each cathode.[6] Adjust resistors for equal cathode currents.
29. Input tube located too close to power transformer. Try tube shield and re-orienting transformer.
30. If low-frequency response is not important, reduce capacitance of coupling capacitors and resistance of grid resistors.
31. Sheet-iron shield needed around power transformer.
32. Replace input transformer with one having several telescoping alloy shields.
33. Use physically smaller input transformer.



"He got an inferiority complex?"

Last ditch measures

1. Use d.c. on heaters.
2. Use high-frequency a.c. heater supply.[7]
3. Apply d.c. bias (about + 45 to 60 volts) to a.c. heaters.[7]
4. Rebuild power supply on separate chassis.
5. Apply a hum voltage 180 degrees out of phase with existing hum.[3]
6. Install negative feedback loop that provides maximum feedback at the hum frequency.[3]
7. Install 1:1 audio-isolation transformer (with electrostatic shield between windings) in input circuit ahead of input transformer, or replace input transformer with one having an electro static shield.
8. Rebuild amplifier on nonmagnetic chassis.

References

[1] *Principles and Practices of Radio Servicing* by H. J .Hicks. 2nd Edition, page 103.
[2] "Controlling Hum in Audio Amplifiers" by Lawrence Fleming. *Radio News*, November, 1950.
[3] "Hum Elimination" by J. C. Hoadley. RADIO-CRAFT, February, 1946.
[4] "Hum Reduction" by A. F. Dickerson. *Electronics*, December, 1943.
[5] *Recording and Reproduction of Sound* by Oliver Read. 2nd Edition, page 670.
[6] "Reducing Hum Levels" by Jack King. RADIO-CRAFT, June, 1946.
[7] "Heater Supplies for Amplifier Hum Reduction" by Frederick W. Smith. *Audio Engineering*, August, 1948.

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